STATE WATER RESOURCES CONTROL BOARD
UNDERGROUND STORAGE TANK REGULATIONS
TITLE 23, DIVISION 3, CHAPTER 16, CCR

FINAL STATEMENT OF REASONS
INCLUDING SUMMARY AND RESPONSE TO COMMENTS

PROBLEM, REQUIREMENT, OR OTHER CONDITION ADDRESSED

These regulations amend section 2611 in Title 23 of the California Code of Regulations (CCR). These regulatory changes are needed in order to clearly define the term "Interstitial Liquid Level Measurement" (ILLM) as used in Health and Safety Code (H&SC) section 25290.1.

UPDATED INFORMATION

The Initial Statement of Reasons is included in this file. There were no changes to the proposed regulation during the course of this rulemaking. However, the information contained in the Initial Statement of Reasons is updated as follows:

The Notice of Proposed Rulemaking for these regulations was published in the California Notice Register on October 22, 2004. The State Water Resources Control Board (State Water Board) held a public hearing on December 10, 2004. Comments were received at the hearing and in writing within the 50-day formal comment period. The State Water Board did not modify the proposed regulation in response to the comments received.

Most of the comments submitted during the formal comment period concerned the merits and/or flaws of ILLM monitoring systems and vacuum monitoring systems. Although the State Water Board has chosen to respond to these comments in the rulemaking record (see Summary and Response to Comments section of this document) they are not direct comments on the proposed regulation. The proposed regulation is not intended to promote one technology over another. Instead, the regulation is intended to resolve any ambiguity in the statute relative to the use of ILLM monitoring systems on underground storage tanks installed on or after July 1, 2004 pursuant to H&SC 25290.1. Specifically, the regulation will ensure that ILLM monitoring systems used on underground storage tanks (USTs) installed on or after July 1, 2004 meet the performance standard defined in H&SC section 25290.1(e), that "a breach in the primary or secondary containment is detected before the liquid- or vapor-phase of the hazardous substance stored in the underground storage tank is released into the environment." Although many comments argued that non-over-pressured ILLM systems were adequate, no evidence was presented that compelled the State Water Board to change its position that non-over-pressured ILLM methods do not meet the aforementioned performance standard.

At least one interested party stated informally during the comment period that, in their opinion, *any* ILLM method is acceptable under H&SC section 25290.1(e), regardless of whether the method meets the performance standard of detecting a breach in primary or secondary containment prior to the release of hazardous substance to the environment. The State Water Board maintains the position that such an interpretation of the statute would lead to an absurd result and could not have been intended by the Legislature. Given the language of the statute and the context of that language in Chapter 6.7, it is clear that the Legislature intended for all methods (ILLM, vacuum, and pressure) to meet the same strict performance standard of detecting breaches in the primary or secondary containment *before* there is a release to the environment. Several factors support this interpretation and the need for the proposed clarifying regulation, as follows.

Performance standard intended for ILLM methods. No other performance standard for ILLM methods for USTs installed on or after July 1, 2004 exists in statute or regulation. If the Legislature had intended for ILLM methods to be held to a different performance standard than that for vacuum or pressure systems, it is reasonable to conclude that they would have either included that standard in statute or else directed the State Water Board to promulgate regulations defining a performance standard for ILLM methods.

Existing ILLM method met performance standard. The only type of ILLM monitoring system known at the time H&SC section 25290.1(e) was adopted by the Legislature was the "over-pressured" ILLM system for tanks, which met the required statutory performance standard. A discussion of why non-over-pressured ILLM systems do not meet the performance standard can be found in the Appendix of the Response to Comments, at the end of this document.

History of increasingly stringent performance standards. In adopting H&SC section 25290.1 the Legislature established a new, more environmentally protective standard for construction and monitoring of UST systems installed on or after July 1, 2004. This increasing level of protection is evident by examining the history of the design and construction standards imposed by Chapter 6.7 and the manner in which newer USTs are required meet ever-more stringent standards. (See H&SC §§ 25292 (imposing upgrade standards for USTs installed prior to 1984); 25291 (establishing design and construction standards for USTs installed between 1984 and July 1, 2003); 25290.2 (establishing design and construction standards for USTs installed on and after July 1, 2003 and before July 1, 2004); and 25290.1 (establishing design and construction standards for USTs installed on or after July 1, 2004.)

Consequences of failure to define ILLM. Since there is no official definition of ILLM monitoring, the State Water Board must adopt regulations that hold all ILLM monitoring systems to the performance standard. Otherwise, potentially any new monitoring system would be deemed adequate simply by: (1) containing liquid in the interstice, and (2) monitoring the level of that interstitial liquid. These methods could actually be less protective than the monitoring requirements that existed prior to the adoption of H&SC section 25290.1. The following are some examples of ILLM monitoring systems that would have to be deemed adequate, absent the regulation.

(a) The monitoring liquid would not have to fill the interstice and thus could be monitoring only a minute portion of the containment. Clearly, any breach above the liquid level would not be detected.
(b) The monitoring liquid could be so viscous (like molasses) as to render the system almost totally insensitive to any of the level changes that signal a breach in containment.

(c) The monitoring liquid reservoir could be so large (size of a house), relative to the volume of the interstitial space, that changes signaling a breach in containment could not be observed.

All of these potential ILLM monitoring systems could lead to releases to the environment prior to detection of a breach. In fact, they could not even perform adequately to meet the pre-AB 2481 performance standard. This would give rise to an absurd result of nullifying the more stringent design and construction standards clearly envisioned by the Legislature.

SECTION 57004 – SCIENTIFIC PEER REVIEW

During discussion of the proposed regulation at the May 3, 2005 State Water Board Workshop (see attached Supplemental Materials), there was a suggestion that the scientific basis for the proposed regulation may require peer review in accordance with Health and Safety Code Section 57004. After thorough review, State Water Board legal counsel has determined that H&SC section 57004 is not applicable to this proposed regulation. The reason is that the "scientific basis" of the proposed regulation was established in and is required by the referencing statute, Health and Safety Code Section 25290.1, subdivision (e). The referencing statute provides that the interstitial space of newly installed underground storage tanks "shall be maintained under constant vacuum or pressure such that a breach in the primary or secondary containment is detected before the liquid or vapor phase of the hazardous substance stored in the underground storage tank is released into the environment." The "science" in the statute is maintaining the interstitial space of the underground storage tank under vacuum or pressure in such a manner that breaches will be detected before a release to the environment. The Appendix discusses this reasoning for the various monitoring systems in more detail.

The proposed regulation is based on the science established in and required by the referencing statute. Specifically, the proposed regulation clarifies that Interstitial Liquid Level Measurement methods must have the required vacuum or pressure in order to meet the statutory performance standard of detecting breaches before a release to the environment. [In this case, the regulation specifies that over-pressure is required since a liquid cannot be put under a vacuum.]

ALTERNATIVES CONSIDERED

The State Water Board has considered alternatives to these regulations within the scope allowed by H&SC section 25290.1. The State Water Board has determined that no alternative to these regulations would be more effective or as effective and less burdensome to the affected industry, local governments, and state agencies than the proposed regulations.

FISCAL AND ECONOMIC IMPACT ESTIMATES

Mandates on Local Agencies and School Districts pursuant to Part 7 (commencing with section 17500) of Division 4 of the Government Code: The State Water Board has determined that the proposed regulations would not impose a mandate on local agencies or school districts nor are there any costs for which reimbursement is required by Part 7 (commencing with Section 17500) of Division 4 of the Government Code. There are no other non-discretionary costs or savings imposed upon local agencies or school districts.

Cost or Savings to any State Agency: The State Water Board and the Regional Water Quality Control Boards will not incur additional costs or savings as a result of the proposed regulations. Other State agencies will not incur additional costs or savings as a result of the proposed regulations.

Other Non-discretionary Costs or Savings to Local Agencies: The State Water Board has determined that the proposed regulations would not impose a mandate on local agencies or school districts nor are there any costs for which reimbursement is required by Part 7 (commencing with Section 17500) of Division 4 of the Government Code. There are no other non-discretionary costs or savings imposed upon local agencies or school districts.

Cost or Savings in Federal Funding to the State: The State Water Board has determined that the regulation will involve no costs or savings in federal funding to the State.

Statement of Significant Statewide Adverse Economic Impact Directly Affecting California Businesses: The State Water Board has made a determination that the regulations will not have a significant statewide adverse economic impact directly affecting businesses, including the ability of California businesses to compete with businesses in other states.

Types of Businesses Affected: Any business that plans to install a new UST system that is not categorically exempt from the UST regulations may be affected by the proposed regulations. These businesses are mostly retail fuel service stations either owned or leased-out by major petroleum distributors, or small, independently owned facilities. Other businesses affected include those that own or operate USTs for their own use, such as factories, equipment rental yards, construction companies, mines, etc.

Projected Reporting, Record Keeping, and Other Compliance Requirements: None

Potential Impact on Private Persons or Businesses Directly Affected: The State Water Board is not aware of any cost impacts that a representative private person or business would necessarily incur in complying with the proposed action.

Effect on the Creation or Elimination of Jobs within California: The State Water Board has determined that these regulations will not have any effect on the creation or elimination of jobs within California.

Effect on the Creation of New Businesses or Elimination of Existing Businesses within California: The State Water Board has determined that these regulations will not have any effect on the creation of new businesses or elimination of existing businesses within California.

Effect on the Expansion of Businesses Currently Doing Business in California: The State Water Board has determined that these regulations will not have any effect on the expansion of businesses currently doing business in California.

Potential Significant Impact on Housing Costs: None.

EFFECT ON SMALL BUSINESS

The State Water Board has determined that this regulation will not have any effect on the small businesses within California. This regulation would not impact existing UST facilities, and only affects new UST systems. There are several monitoring methods that are not impacted by this regulation, are currently available, and comply with the monitoring requirement for new UST systems.

SUMMARY AND RESPONSE TO COMMENTS RECEIVED DURING THE 50-DAY COMMENT PERIOD OF OCTOBER 22, 2004 TO DECEMBER 10, 2004.

Health and Safety Code section 25290.1, subdivision (e) provides that, with respect to underground storage tanks installed on or after July 1, 2004, "The interstitial space of the underground storage tank shall be maintained under constant vacuum or pressure such that a breach in the primary or secondary containment is detected before the liquid or vapor phase of the hazardous substance stored in the underground storage tank is released into the environment." Subdivision (e) continues by stating that, "The use of interstitial liquid level measurement methods satisfies the requirements of this subdivision."

The purpose of this proposed regulation, which defines the term "Interstitial Liquid Level Measurement Method," (ILLM) is to clarify that the two sentences in subdivision (e) must be read in context with one another, given the ILLM technology existing at the time the statute was adopted, in order to effectuate the statutory performance standard of detecting breaches *before* a release to the environment.

At the time section 25290.1 was adopted, existing ILLM technology was in use for tanks only and was an "over-pressure" technology which met the statutory performance standard of detecting breaches before the substance stored could reach the environment. (See Appendix for a discussion of this technology, and vacuum and pressure technologies as compared to the "non-over-pressured ILLM" technology.) It was this "over-pressure" ILLM technology that the statute was intending to allow. After the statute was adopted, manufacturers developed a "non-over-pressured" ILLM technology for pressurized piping that does not meet the required performance standard. The proposed regulation clarifies that this technology was not envisioned by the statute and is not allowable.

We received many comments during the comment period. None of these comments were related to the central issue of how the two sentences in subdivision (e) of section 25290.1 should be reconciled. Instead, the comments tended to focus on why one technology was better or more efficient than another. Strictly speaking, none of these comments are relevant objections or recommendations directed at the proposed regulation. Nonetheless, we have chosen to respond to those comments that articulated a specific technical argument regarding the proposed regulation. These selections are annotated on the original comment letters and hearing transcript included in this rulemaking record. Response to these comments serves to demonstrate that only the over-pressure ILLM technology meets the required statutory performance standard of detecting breaches *before* a release to the environment and is therefore acceptable.

1. **Balanced holes in the primary and secondary piping are highly improbable. A non-over-pressured ILLM system would detect the same leaks that would be detected by a vacuum system. (RSE1-3, RSE3-1, WR-2, MLo-1, TS-3, JF-5, JF-6, JR-1, ML-3, ML-14, ML-H-4, ML-H-6, JR-H-1, WR-H-1, RS-H-4)**

Comment not incorporated. Non-over-pressured ILLM systems are leak detection, not leak prevention, systems and are therefore unable to meet the statutory performance standard. Even the simplified mathematical analysis submitted during the comment period acknowledges that there can be a release, albeit small, to the environment prior to detection. The following discussion illustrates the flaws in the commenter's analysis of how releases occur in the real world.

The simplified analysis of the “balanced hole” argument submitted by one commenter makes several assumptions that experience has shown are not likely to be true of piping systems. The simplified analysis also does not address many of the factors listed in the Appendix that could affect the ability of a non-over-pressured ILLM system to detect breaches prior to a release. The very fact that a commenter made unfavorable comparisons of his competitor’s non-over-pressured ILLM system with his own system, highlights the fundamental issue that non-over-pressured ILLM methods do not meet the performance standard under all scenarios.

Real-world evidence has shown that significant environmental contamination can occur because of small breaches in containment that go undetected over the life of an operating UST system. In pressurized piping, common sources of small breaches of containment include threaded fittings and piping joints with complex geometry. These small breaches in containment do not behave as described in the commenter’s simplified analysis, which is based on a formula that is only accurate when describing a relatively large hole in relation to the thickness of the pipe wall.

The flow through a given hole is also significantly dependent on the shape of that hole. The shape of any given hole corresponds to a specific flow coefficient, often noted in fluid mechanics equations as “K”. The simplified analysis submitted during the comment period is based on an assumed flow coefficient of 0.6, which is only valid for a very specific shape of hole. Further complications may arise given that many brands of piping are constructed of flexible plastic materials. Holes in flexible pipes would likely change size and shape as pressure in the primary pipe changes. This change of hole shape would result in a change of flow coefficient. During his testimony at the hearing, the commenter acknowledged that his simplified analysis did not take hole shape into account.

The simplified analysis also assumes a constant pressure in the primary piping. In reality, the pressure in the primary piping fluctuates as the pump is turned on and off throughout the day. Each time product is dispensed from the pipe, the pump is on. When no product is being dispensed, the pump is off. When the pump is on, pressure in the primary piping is typically between 30 and 40 pounds per square inch (psi). When the pump is off, pressure will typically drop to 12-15 psi. If there is a leak in the primary pipe, or a malfunctioning check valve, pressure will drop to 0 psi when the pump is off. This cyclic fluctuation in pressure throughout the day is not uniform, and not adequately described by a simplified analysis. It varies depending on the frequency and duration of dispensing from the piping, which are not controlled factors.

The rate of flow through any hole is dependent upon the pressure. Accordingly, in the event of a hole in the primary pipe, fluctuations in pressure within the primary result in fluctuations in the rate of flow of hazardous substance into the secondary piping. This effect would be compounded if small cracks and flaws in the piping opened up and leaked when the pipe was pressurized, but closed up and did not leak when the pressure was reduced. Far from the constant flow described in the simplified analysis, the actual flow through a hole on the primary piping would cycle between higher and lower rates, or may even behave in a “leak on” and “leak off” manner.

In a non-over-pressured ILLM system, pressure of the liquid in the secondary space is directly proportional to the height of liquid in the reservoir. The pressure is roughly equal to 0.5 psi for every foot of height in the reservoir, typically about 2 psi total. Because the liquid level only needs to change a few inches to activate an alarm, this pressure is essentially constant. A fluctuating leak rate in the primary piping, when combined with a constant leak rate in the secondary containment, would have an unpredictable effect on the level of liquid in the secondary piping. While the exact levels would vary depending on the size of the holes and the (uncontrolled) usage pattern of the pump on that piping, levels would follow the general pattern of rising when the pump is on and dropping when the pump is off. This rise and fall of fluid in the interstice allows for the possibility that hazardous substance will move into the interstice and out to the environment without activating an alarm, in violation of the statutory performance standard.

The simplified analysis also does not take into account: (a) the potential distance between breaches in primary piping and secondary containment; and (b) the potential distance between the breaches and the reservoir. Third-party engineering evaluation data from the Western Fiberglass Co-Flow system indicates that the monitoring liquid does not flow easily through the constricted passages of the interstitial space, even when the piping is new. In order to simulate a catastrophic piping failure, a leak through a large orifice at 40 psi was introduced 190 feet from the reservoir. It took 84 minutes for the non-over-pressured ILLM system to detect the leak. In order to simulate a catastrophic failure of the secondary containment, the interstitial space was completely opened up at the far end of a 200-foot run of piping. It took almost 6 hours for the non-over-pressured ILLM system to detect the leak. This delayed response to catastrophic primary and secondary containment failures is not reflected in the simplified analysis submitted during the comment period, and could allow a leak to enter the environment in violation of the performance standard established by section 25290.1(e).

The simplified analysis submitted during the comment period does not address how an UST operator is likely to respond to alarms from non-over-pressured ILLM systems. California has a long history of over-pressure ILLM on double-walled tanks. It is common that the level of monitoring fluid in the interstice drops over time, resulting in an alarm. This indicates a possible leak in the tank. It could also be evaporation of the monitoring fluid, or a trapped air bubble in the interstice that "burps" out of the system and causes the fluid level to drop. Even if monitoring fluid is added to an over-pressure ILLM system for extended periods of time, the method continues to meet the statutory performance standard because the greater pressure in the secondary space means that no hazardous substance can exit the tank and enter the environment. If there is a slow leak in the primary tank wall, the monitoring fluid will eventually be detected as it accumulates at the bottom of the primary tank. If the breach is in the secondary containment, only non-hazardous monitoring fluid is being released to the environment. If breaches exist in both primary and secondary containment, the pressure of the monitoring fluid keeps the hazardous substance contained in the primary tank, even as monitoring fluid is being lost to the environment.

However, if monitoring fluid is added to a non-over-pressured ILLM system for extended periods of time, the leak would be masked, as follows. If a low-level alarm occurred at the reservoir, it could be from evaporation of monitoring fluid or from air escaping from the interstitial space. It could also be a leak in the secondary containment. If monitoring liquid were added, any subsequent leak that developed in the primary containment could then escape to the environment through the existing breach in the secondary containment. In contrast to the claims made by several commenters, the breaches in primary and secondary containment would not need to be simultaneous.

Other factors not addressed by the simplified analysis submitted during the comment period could also affect the performance of non-over-pressured ILLM systems. These include:

monitoring reservoir size (change in volume required to activate an alarm), amount of time between the development of primary and secondary breaches, distance of primary and secondary breaches from one another, distance of primary and secondary breaches from the monitoring reservoir, slope of piping, viscosity of the hazardous substance, viscosity of the monitoring liquid, dimensions of the piping interstice, and structural integrity of the primary and secondary piping materials. Similar to the factors previously discussed, each of these factors may also cause a non-over-pressured ILLM method to behave differently than shown in the simplified analysis.

2. The National Work Group on Leak Detection Evaluations (NWGLDE) has listed ILLM systems for use on pressurized piping. Therefore, California should allow the use of these systems. (RS-2, RSE1-1, RSE1-9, WR-1, WR-4, TS-2, TS-5, ML-5, ML-H-1, ML-H-13)

Comment not incorporated. The NWGLDE is an independent work group comprised of State and Federal UST regulators. The NWGLDE reviews third-party engineering evaluation results for UST leak detection equipment and methods, in order to determine that the equipment has been evaluated in accordance with U.S. EPA protocols or equivalent. California and Federal regulations require manufacturers to evaluate their equipment and substantiate any performance claims[1]. To satisfy this requirement, the manufacturer hires a testing company to evaluate their equipment. The third-party engineering evaluator is not responsible for determining the performance capabilities of the system, only for determining whether or not the system can reliably perform to the level claimed by the manufacturer. In the preamble to the Federal UST rule requiring evaluation of monitoring equipment, U.S. EPA writes "In order to successfully market equipment, the manufacturer will have to develop convincing documentation demonstrating that the release detection method meets the minimum performance standard requirements."[2]

For example, a manufacturer may claim that their system can detect leaks of 0.2 gallons per hour (gph). The third-party engineering evaluation will not attempt to determine the minimum leak rate that the equipment can detect. Instead, they will run a series of tests to determine the system's ability to detect leaks of 0.2 gph. In addition to verifying manufacturer's performance claims, the third-party engineering evaluation will also determine performance limitations of the leak detection equipment or method. Relevant information determined during the evaluation (e.g. minimum detectable leak rate, maximum tank size, minimum test duration, pass/fail threshold, etc.) is included in third-party engineering evaluation report. If the NWGLDE determines that an evaluation was conducted in accordance U.S. EPA protocols (or a protocol that is equally stringent), that equipment is added to NWGLDE list.

In California, the NWGLDE list is referred to as LG-113. UST regulators use the information provided in NWGLDE list or LG-113 to determine whether a given leak detection equipment/method is appropriate for use on a particular UST system. It is possible for some leak detection equipment/methods to successfully complete a third-party engineering evaluation, but not meet regulatory requirements at a specific UST facility. This is noted in the following statement, which is printed at the bottom of each equipment/method listing on the NWGLDE and LG-113 list:

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[1] 40 CFR, section 280.40(a)(3) and Title 23, CCR, section 2643(f)
[2] Federal Register, Vol. 53, No. 185, Pg. 37168

Appearance on this list is not to be construed as an endorsement by any regulatory agency nor is it any guarantee of the performance of the method or equipment. Equipment should be installed and operated in accordance with all applicable laws and regulations.

The authority of local regulatory agencies to determine compliance of leak detection equipment/methods with regulatory requirements is further explained in an excerpt from the cover letter of the NWGLDE list, 12th Edition, March 2005, which reads:

The "List" does not include "approved" leak detection equipment/procedures. It includes leak detection equipment/procedures that the work group has reviewed. This review has confirmed that the leak detection equipment/procedures were third-party tested in accordance with either an EPA or other acceptable test protocol. The review also confirmed that the equipment/procedures met EPA performance standards under test conditions. Approval or acceptance of leak detection equipment and procedures is the responsibility of the implementing agency, which in most cases is the state environmental agency.

It is quite common to find equipment/methods on the NWGLDE list that do not satisfy performance standards that are more stringent than those established by U.S. EPA, or do not satisfy regulatory requirements for a specific jurisdiction or UST system. For example, the Brooks KWK, Inc. model KW-140, KW-240 Monitors with Types 1, 2 Sensors are on the NWGLDE and LG-113 lists as an out-of-tank liquid detection method. A detection element within these sensors is deigned to dissolve when it comes in contact with hydrocarbons, destroying the sensor. Once the detection element dissolves, the monitoring system will activate an alarm. These sensors are used in many jurisdictions throughout the United States, but are not allowed in California because they would be destroyed during the functional testing that is required annually for all leak detection equipment in California. (Functional testing is required per California Code of Regulation, Title 23, section 2638.) Another example is the Veeder-Root Model 7842 Digital Sensing Capacitance Probe. This probe has been third-party certified to detect leaks of 0.2 gallons per hour in tanks up to 15,000 gallons. It would meet regulatory requirements in many cases, but not when regulations require detection of leaks of 0.1 gallons per hour, or when the tank is larger than 15,000 gallons. Therefore, the listing of specific equipment in LG-113 is not to be taken as approval for its use in California.

To meet the performance standard established by 25290.1(e), UST systems installed in California on or after July 1, 2004 must be continuously monitored to detect a breach in primary or secondary containment prior to release of liquid or vapor-phase hazardous substance to the environment. The NWGDLE and LG-113 listing for the only ILLM method that is designed for use on piping (Western Fiberglass Co-Flow System) clearly states that the system can detect leaks of a specific rate within a specific time, not that the system can detect breaches in containment prior to release to the environment. For example, one configuration of the Western Fiberglass Co-Flow system can detect a leak of 0.1 gallons per hour within 2.4 hours. Third-party engineering evaluation data also indicates that the system may take between 84 minutes and several hours to detect a catastrophic failure of the primary or secondary piping. This performance is clearly less protective than the law requires. In the future, additional non-over-pressured ILLM methods with performance significantly inferior to the Western Fiberglass system could be designed, third-party evaluated, and added to the NWGLDE and LG-113 lists. Because H&SC Ch. 6.7, sec. 25290.1(e) states that ILLM methods meet the requirement, absent the proposed regulation, it could be argued that any ILLM method meets the statutory requirements, regardless of the system's performance.

This regulation will clarify two issues: (1) that it is only acceptable to use those ILLM systems that can activate an alarm prior to hazardous substance entering the environment, and (2) that a greater pressure in the secondary containment than in the primary containment is necessary in order to meet this performance standard.

ILLM methods are volumetric, meaning they must gain or lose some volume of liquid in the interstitial space in order to activate an alarm. By requiring a greater pressure in the secondary containment than in the primary containment, it is assured that the change in fluid volume required to activate an alarm would not be a result of the stored hazardous substance moving to the environment. In an over-pressured ILLM system, any breach in the primary containment (which stores the hazardous substance inside) would result in movement of the non-hazardous monitoring liquid into the primary containment. This would activate an alarm. Because of the pressure differential, there would be no possibility for movement of hazardous substance into the interstice, and potentially to the environment. This will always be the case, so long as the pressure in the interstice is maintained. With a non-over-pressured ILLM system, there is no assurance that the change in volume of interstitial fluid required to activate an alarm will occur prior to hazardous substance being released to the environment. The likelihood of releasing hazardous substance to the environment prior to alarm is reduced as the volume change required to activate an alarm is reduced. However, because non-over-pressured ILLM systems are volumetric leak detection rather than prevention systems, the statutory performance standard cannot be met.

3. **The proposed regulation would severely limit the number of compliant monitoring systems that could be installed. Some commenters claim that no viable alternatives exist. Lack of choice is bad for industry. (RSE5, JM-1, JM-4, JF-2, ML-1, ML-3, ML-H-12, JM-H-3, JY-H-1)**

Comment not incorporated. As background, the initial effective date for requiring vacuum, pressure, or ILLM monitoring for new UST systems was July 1, 2003. Leak detection and containment systems that could meet this requirement were not widely available at that time, so legislation was drafted to postpone the effective date of the requirement for a year (Assembly Bill 1702, Stats. 2003, Ch. 42.) By July 1, 2004, several containment systems and leak detection systems had been developed and made commercially available that satisfy the statutory requirements.

As of May 2005, three vacuum leak detection systems (Beaudreau, SGB, Veeder-Root) and one pressure leak detection system (SGB) are commercially available to meet the statutory performance standard for monitoring pressurized piping. Each of these systems has successfully completed third-party engineering evaluation, demonstrating that they meet the statutory performance standard. They have also received NWGLDE and LG-113 listing, been approved for electrical/fire safety by Underwriters Laboratories, and are listed on the State Water Board's website. Additional vacuum and pressure based leak detection systems (Rietschle-Thomas, Franklin Fueling Systems) are undergoing NWGLDE review, and are expected to enter the market in the coming months. Furthermore, there are many manufacturers of tanks and other UST components that are currently being installed with over-pressure ILLM monitoring. This shows that there are several available vacuum and ILLM systems that (unlike non-over-pressured ILLM methods) meet the statutory performance standard.

This regulation clarifies that the statute prohibits the use of non-over-pressured ILLM methods on pressurized piping. As allowed by H&SC, Ch. 6.7, section 25290.1(e), many of the UST systems installed on or after July 1, 2004 have legally and properly used over-pressure ILLM as one of the methods to monitor one or more components of the UST system. In fact, approximately half of the roughly 50 UST systems installed between July 1, 2004 and the date of this report have used over-pressure ILLM methods to monitor fiberglass tanks, double-walled tank-top sumps, or double-walled under-dispenser containment boxes. There are also a few installations where over-pressure ILLM has also been used to monitor non-pressurized piping. These designs would still be allowable once this regulation is made permanent.

4. **ILLM systems are much more protective than vacuum systems in the event of a power outage. ILLM systems will continue to provide monitoring, while vacuum systems would be completely disabled. (ML-9, RSE1-7, TSEA-4, WR-H-4, RS-H-3)**

Comment not incorporated. ILLM and vacuum systems use similar (often identical) monitoring system control panels to activate audible and visual alarms in the event of a leak. Both types of systems would be unable to activate audible and visual alarms when power is lost. The basis of these comments seems to be that the liquid level in an ILLM system can be visually inspected during a power outage, while vacuum levels cannot be visually inspected. This concern is addressed by installing a manual vacuum gauge in a visible location. Installation of a manual vacuum gauge is not required by State law, but many local regulatory agencies have specified that gauges be installed to aid the annual UST inspection process. Contractors have also found manual gauges useful for installation quality control and system trouble-shooting. Installation of manual vacuum gauges is inexpensive, and has become a very common practice. Visual inspection of liquid level in the reservoir would let an operator know that their containment was not leaking. Likewise, visual inspection of a manual vacuum gauge would let an operator know that their containment was not leaking.

There is a misconception among some commenters that vacuum systems must continually be recharged or they will go into alarm. This has not been the case at the many systems with vacuum monitoring that are currently in operation. Typically, vacuum levels are maintained without a recharge for a period of time ranging between 8 hours and several days. In some cases, where the system was installed properly and permeation levels are low, weeks can go by without the need for a vacuum recharge. It is true that, in an identical containment system, the vacuum level would drop to the alarm point more quickly than would the ILLM liquid level. However, vacuum levels will not immediately drop to zero just because power is lost, as implied by some commenters. With the use of simple manual vacuum gauges, vacuum and ILLM systems can provide the same visual indicator of tightness in the event of a power outage. Additionally, as long as vacuum remains in the secondary containment, it will continue to act to prevent releases to the environment.

5. **Shutting down the turbine when an alarm occurs effectively disables a vacuum system, whereas an ILLM could continue monitoring while the pump is shut down. (RSE1-5, RS-H-3)**

Comment not incorporated. As discussed in the second paragraph of the response to comment 4, above, interstitial vacuum will not immediately be lost just because the turbine pump has been shut down. Vacuum levels will remain within acceptable limits for hours or days, depending on how tight the UST system is. The remaining vacuum continues to act to prevent releases of hazardous substance to the environment. If vacuum levels drop below acceptable limits in a particular interstitial space, a second alarm will be activated by the vacuum sensor monitoring that space. This method is at least as protective as the interstitial space being monitored using a non-over-pressured ILLM method.

6. ILLM systems use food-grade propylene glycol, which is not a threat to the environment. (RSE1-6, TSEA)

Comment not incorporated. The subject of the regulations is not whether or not the ILLM monitoring fluid poses a threat to the environment. Instead, the subject of the regulations is the threat to the environment posed by the hazardous substance stored in the UST system. As discussed in the Appendix to this document, non-pressurized ILLM methods may allow the hazardous substance stored to be released to the environment prior to detection.

7. SWRCB's reasons for the proposed regulation are based on unproven theories, with no lab or field analysis. Some independent testing should be done to support SWRCB's position. (JM-2, ML-H-3, JM-H-1)

Comment not incorporated. As discussed on page 3 of the Final Statement of Reasons, "Section 57004 – Scientific Peer Review," the "scientific basis" of the proposed regulation was established in and is required by the referencing statute, Health and Safety Code Section 25290.1, subdivision (e). The scientific basis that is established in this statute is consistent with the results of third-party engineering evaluations conducted on non-over-pressured ILLM methods. Two such evaluations were reviewed by SWRCB staff with extensive experience and technical expertise in the area of underground storage tank leak detection. SWRCB staff involved in this process included a California Registered Professional Engineer (with Mechanical and Civil registration) and a member of the National Work Group on Leak Detection Evaluations (NWGLDE). After staff review of the evaluations, the State Water Board found that non-over-pressured ILLM systems cannot meet the statutory performance standard of detecting breaches prior to the release of hazardous substance to the environment.

8. The SWRCB's position on vacuum monitoring assumes a single failure, while their position on ILLM systems assume simultaneous multiple failures. (ML-7, WR-3)

Comment not incorporated. The statutory performance standard requires detection of a breach in the primary or secondary containment prior to the release of hazardous substance to the environment. This standard applies whether the breach occurs in the primary containment, secondary containment, or both. The commenter is incorrect in suggesting that SWRCB staff did not consider how vacuum systems would respond in the event of multiple failures. Third-party engineering evaluations of vacuum monitoring systems do not include separate testing of primary and secondary containment breaches because the vacuum monitoring system will respond in the same manner (i.e., loss of interstitial vacuum) in either case. In contrast, non-over-pressured ILLM systems have a different response (i.e., rise in liquid level when the primary is breached, fall in liquid level when the secondary is breached) to breaches in the primary and secondary containment. Therefore, third-party engineering evaluations of non-over-pressured ILLM systems needed to include separate testing of the system's response to breaches in the primary and secondary containment. The appendix to this document explains the ways in which vacuum and overpressure systems (including over pressure ILLM systems) meet the performance standard in the case of single and multiple failures, and the ways in which non-over-pressured-ILLM systems do not.

9. The proposed regulation is an attempt to change Assembly Bill 2481 without going through the legislative process. (JF-1)

Comment not incorporated. Given the language of the statute and the context of that language in Chapter 6.7, it is clear that the Legislature intended to impose a stricter performance standard, and intended for all methods to meet this same strict performance standard of detecting breaches in the primary or secondary containment *before* there is a release to the environment. The only ILLM method known at the time AB 2481 was adopted, brine tanks, clearly met this performance standard, therefore that method was specifically named as acceptable. However, as described in the appendix to this document, non-over-pressured ILLM methods do not meet the statutory performance standard. The proposed regulation is meant to preserve the intent of the statute.

10. SWRCB UST Program staff drafted this regulation after visiting a European leak detection vendor whose system would benefit from the regulations. (JF-4)

Comment not incorporated. This comment, as well as numerous other comments submitted, does not speak to the central issue of how the two sentences in subdivision (e) of section 25290.1 should be reconciled; nevertheless we are choosing to provide a response. The implication that the proposed regulations were drafted in a manner to purposefully benefit a single leak detection vendor is incorrect. One of the regular duties of UST Program staff is to meet with a wide variety of stakeholders to receive input on the variety of issues, including proposed regulations. With respect to monitoring methods designed to meet the requirements of subdivision (e) of section 25290.1 staff met with several vendors, including this commenter. The proposed regulation was not based on whether there would be any benefit or detriment to any particular vendor. Instead, the regulation is based on the need to clarify the language in the statute to ensure the required performance standard is met.

11. Vacuum systems will use a lot of electricity, increasing operating costs and placing a demand on California's electrical supply. (ML-17, RSE1-8, RS-H-3)

Comment not incorporated. Over 90% of the UST systems currently in operation using vacuum monitoring systems are designed such that a siphon port on the product pump generates the required vacuum. For these systems, the same pump that is used to move product from the tank to the dispenser is also used to generate vacuum for monitoring. Independent of the vacuum monitoring system, this pump is activated each time product is dispensed from the tank. When a vacuum recharge is needed, the vacuum monitoring system simply taps into the vacuum already being generated by this pump during normal dispensing activities. The vacuum monitoring system is able to turn the pump on if a vacuum recharge is needed but no dispensing has occurred for an extended period of time. However, this is very rare. Typically, vacuum levels can be maintained without any additional pump run time.

Less than 10% of the UST systems currently using vacuum monitoring methods use a separate pump to generate vacuum. Because there is an additional electric pump, these systems would cause a slight increase in power usage at the UST system. However, the increase is very minor.

The vacuum pumps use a single, 1/2 horsepower electric motor for a complete UST facility. The pump motor draws a maximum of 6.0 amps at 115 volts. Pumps typically run somewhere between 5% and 25% of the time, with 35% run-time being the highest we have heard of in operating UST systems. Assuming 35% runtime, power usage would be approximately 175 kilowatt hours per month. At typical commercial power rates (12 cents per kWh), this would be roughly $21 per month.

In summary, more than 90% of the new vacuum systems do not pose additional power demands. The demand posed by the remaining <10% of new vacuum systems is negligible.

12. Vacuum systems will discharge hazardous vapors into the atmosphere, whereas ILLM systems do not. By discharging hazardous substance to the atmosphere without first activating an alarm, vacuum systems are not in compliance with H&SC, Ch. 6.7, sec. 25290.1(e). ILLM systems are more environmentally friendly because they do not discharge hazardous vapors to the atmosphere. (JF-8, JF-9, ML-15)

Comment not incorporated. Because the California Air Resources Board (CARB) regulates releases of hazardous substances into the atmosphere, State Water Board UST Program Staff consulted CARB staff early in the 25290.1 implementation process regarding discharges from vacuum monitoring systems. CARB staff reported that they were not concerned about the discharge because the limited flow rate and low concentration of hazardous substance was well below their allowable thresholds.

Vacuum systems do periodically evacuate a small amount of air from the interstitial space of the UST system, and this air may contain vapors from the hazardous substance stored in the UST system. However, the most common vacuum system (> 90% market share) does not discharge this air to the atmosphere. Instead, this vacuum system discharges air into the primary tank. This helps to keep the interstitial space free of hazardous substance, without discharging anything to the atmosphere.

The few (< 10 % market share) vacuum systems that do discharge air to atmosphere are still compliant with the H&SC, Ch. 6.7, sec. 25290.1(e) requirement to activate an alarm prior to a release of hazardous substance to the environment. The term “release” is defined for the purposes of H&SC Ch. 6.7 in section 25281(p). The definition is limited to “any spilling, leaking, emitting, discharging, escaping, leaching, or disposing from an underground storage tank into or on the waters of the state, the land, or the subsurface soils.” Based on this definition, a small discharge of vapors to atmosphere is not a release.

13. Vacuum systems can leak up to 85 liters per hour, while ILLM systems will alarm when as little as a few ounces of product are added or removed from the interstitial space. (RSE1-4, RSE5, TSEA-1, TSEA-3, JF-7, ML-4, ML-10, ML-H-10, ML-H-11, WR-H-2, RS-H-1)

Comment not incorporated. This comment demonstrates a fundamental misunderstanding about how vacuum monitoring systems operate. It is true that vacuum systems allow some volume of air to be removed from the interstitial space in order to maintain vacuum levels within set limits. This removal of air is NOT a leak to the environment. The recharge of vacuum is simply a way to compensate for changes in the system, including fluctuations in atmospheric pressure, changes in temperature, and permeation through the inner and outer piping wall. If the volume of air required to maintain the interstitial vacuum exceeds 85 liters per hour, the system will activate an alarm. In addition, there are several other mechanisms that will also activate an alarm in vacuum monitoring systems.

- Liquid Detection Alarm: Vacuum monitoring systems incorporate a liquid sensor in the vacuum evacuation line. As the vacuum pump cycles on to recharge interstitial vacuum levels, any liquid in the interstice will be sucked up through the line and into a liquid sensing chamber. Once liquid enters the sensing chamber, a float switch sensor detects it and activates an alarm.

- Low Vacuum Level Alarm: If vacuum levels decrease below the minimum allowable rate, a vacuum alarm is activated. Maintaining the minimum vacuum level acts to ensure that any breach in the primary or secondary containment will result in fluid (air, groundwater, liquid stored product, or vapor stored product) entering the interstitial space rather than entering the environment. The vacuum level is set such that even if the interstitial space was full of product and a hole were drilled in the bottom of the secondary containment, air/groundwater would flow into the interstice rather than product flowing out to the environment. By maintaining this vacuum level, vacuum monitoring systems provide true leak prevention, consistent with the intent of H&SC 25290.1(e). The following formula describes minimum vacuum alarm level requirements:

Alarm Pressure = (Density of Product) x (Gravity) x (Maximum Height of Product) + Safety Margin

- No Headway Alarm: When a new UST system is installed with vacuum monitoring, vacuum is applied to the interstitial space. If there are any leaks in the primary or secondary containment, the vacuum pump will not be able to establish the required vacuum. This activates an alarm, and the system cannot be placed into service until the leak(s) are identified and repaired.

By allowing a limited recharge of interstitial vacuum, nuisance alarms caused by thermal and atmospheric pressure changes are avoided while the performance standards of 25290.1 are still met.

14. Vacuum monitoring systems are much more expensive than non-over-pressured ILLM systems, as much as $67,000 more over a ten-year period. Jobs could be lost. (RS-3, RSE1-8, RSE5, JM-3, TSEA-5, ML-2, ML-16, ML-H-7, ML-H-8, WR-H-3, TH-H-1, RS-H-2, JM-H-2, JM-H-4)

Comment not incorporated. After analyzing the costs associated with equipment purchase, installation, and operation of the monitoring system, we did not find a significant difference in costs between non-over-pressured ILLM and vacuum methods for monitoring piping. Each cost element is discussed in the following paragraphs.

Equipment Costs

Although we are not aware of any ILLM systems currently installed on pressurized piping, the equipment would be identical to that which has been used for ILLM monitoring of suction piping. Based on prices provided by monitoring equipment manufacturers and distributors, there does not appear to be a significant price difference between the non-over-pressured ILLM method and vacuum methods for monitoring piping. In fact, the vacuum monitoring equipment required for piping is actually slightly less expensive than the non-over-pressured ILLM monitoring equipment. Table 1 (below) shows a breakdown of equipment costs for non-over-pressured ILLM and vacuum systems to monitor three piping runs, as would commonly be found at a typical retail fueling facility. Table 1 is limited only to equipment required for monitoring of piping, since the proposed ILLM definition would not have any impact on the use of ILLM methods on other UST system components (such as tanks, sumps, and under-dispenser containment).

Table 1

Cost Comparison of Vacuum and Non-over-pressured ILLM Monitoring Methods for Piping

Assumptions: 1) Three product lines at the UST facility
2) All systems use the Veeder-Root TLS-350 monitor and associated sensors.

System A: Non-over-pressured ILLM Monitoring of Piping (3 product lines)

Component	Unit Cost High	Unit Cost Low	Unit Cost Average	Quantity	Total
8-Input Sensor Module*	$655.00	$582.00	$618.50	1	$618.50
Dual Point Hydrostaic Sensor	$335.00	$294.00	$314.50	3	$943.50
Co-Flow Reservoir Kit	--	--	$374.25	3	$1,122.75
Monitoring Fluid (5 Gal.)	--	--	$131.25	1	$131.25
Total					**$2,816.00**

* Note: If there are three unused inputs on an existing sensor input module, there is no need to buy this component for ILLM monitoring of piping.

System B: Vacuum Monitoring of Piping (3 product lines)

Component	Unit Cost High	Unit Cost Low	Unit Cost Average	Quantity	Total
7-Input Smart Sensor Module*	$812.00	$582.00	$697.00	1	$697.00
3-Sensor Vacuum Kit	$1,823.00	$1,334.00	$1,578.50	1	$1,578.50
Vacuum Hose (100 ft.)	--	--	$143.00	1	$143.00
NPT Barbed Fittings (15 ea.)	--	--	$22.00	1	$22.00
Siphon Check Valve	--	--	$28.80	1	$28.80
1 1/4" Ball Valve	$108.00	$30.00	$69.00	3	$207.00
Total					**$2,676.30**

*Note: If there are three unused inputs on an existing Smart Sensor input module, there is no need to buy this component for vacuum monitoring of piping.

These are only the costs for equipment used to monitor pressurized piping, because the proposed regulation would only impact monitoring of pressurized piping.
Additional equipment is needed to monitor the rest of the UST system.
All other monitoring equipment at facilities A and B would be interchangeable.
Other monitoring equipment includes control panel, line leak detectors, tank gauges, sump/UDC sensors, and associated wiring.

Installation Costs

It is difficult to obtain an exact installation cost of only the vacuum and non-over-pressured ILLM monitoring systems for piping because the systems are part of the much larger and more expensive project of installing a new UST system. Instead, we can only examine the installation process and seek to identify required tasks that could affect the costs of installing one system as compared to another. We understand that both systems have identical requirements for installation of the piping and monitoring system control panel. We understand that both systems require similar wiring from the control panel to the sensor (either liquid level or vacuum sensor). We understand that both systems require a similar connection to the interstitial space of the piping. The non-over-pressured ILLM system requires installation of two reservoirs and one liquid sensor for each run of piping, while vacuum systems require installation of a vacuum sensor for each run of piping. We believe the cost of installing these components should be roughly equal. The interstitial space of piping monitored by a non-over-pressured ILLM system must be filled with monitoring fluid in the field, while the interstitial space of vacuum systems must be evacuated to the appropriate vacuum level. Contractors have reported that it is quicker and easier to evacuate the interstitial space than to completely fill it with liquid. On the other hand, there is some additional programming of the control panel that must be done with vacuum systems that is not required for ILLM systems. Overall, the installation requirements for ILLM and vacuum systems monitoring piping appear to require essentially the same amount of labor. Our best information is that the installation cost is roughly equal.

Operating Costs

There may be a small cost associated with continued operation of the vacuum pump. As discussed in the response to Comment 5, most vacuum monitoring systems installed use the turbine pump to generate vacuum. This pump runs whenever product is dispensed from the tank, and using it to produce vacuum for monitoring will not cause additional wear and tear on the pump. Therefore, no additional operating costs are incurred. For vacuum monitoring systems that use a stand-alone vacuum pump, there will be a cost associated with operating and maintaining the pump. Based on the observed worst case of 35% pump run time, the cost of electricity to operate the vacuum pump is $21/month or $252 annually. The vacuum pumps used for this application are designed for industry use at 100% runtime. Therefore, it is reasonable to assume that they will operate reliably for many years. However, if the pump were to fail, there would be a cost associated with repair/replacement. According to one manufacturer of a vacuum monitoring system with a stand-alone pump, a new pump would cost $1750 installed. Costs for other manufacturers may vary. In any case, the cost of operating a vacuum monitoring system is a minimal portion of the total costs associated with operating an UST system.

Annual Monitoring System Certification

Contrary to some comments received, annual functional testing and certification of all monitoring equipment is required in California.[3] This applies to both ILLM and vacuum systems. Some comments indicated that it would take two or three days to complete monitoring system certification for a vacuum system, while no certification was required for ILLM. State Water Board staff has observed monitoring system certification on vacuum and ILLM systems. Based on these observations, there is little difference in the time (and resultant expense) required for testing and certifying these systems.

Job Loss

One commenter indicated that the regulation would cost California 30 to 40 jobs. When asked for further clarification, the commenter indicated that these jobs did not currently exist. Instead, the jobs represented potential expansion that the commenter's company and its suppliers may realize if the regulation were not adopted. Because the regulation clarifies the statute, it does not

[3] CCR, Title 23, section 2638

prohibit anything that is not currently prohibited. Therefore, there is no reason to believe that any jobs will be gained or lost as a result of this regulation.

15. Maintaining a vacuum in the interstitial space may damage the piping. (RSE1-10, RSE4-2, RSE5, TSEA-2)

Comment not incorporated. State Water Board UST Program staff have encouraged and facilitated communication between the manufacturers of vacuum monitoring systems and the manufacturers of the tanks, piping, and other components that are monitored using vacuum. Vacuum monitoring systems in use in California use a relatively low vacuum level, typically between 1" mercury (Hg) and 15" Hg. Maintaining vacuum at this level places a minimal stress on the components being monitored. Underwriter's Laboratories (UL) testing standard 971, used to evaluate piping, includes tests of the ability of piping to withstand vacuum. UL 971 includes 250,000 tests cycles where the piping is placed under vacuum, then returned to non-overpressured pressure. After the 250,000 cycles, the piping must show no leakage or degradation in order to pass the UL evaluation.

Some commenters referred to studies showing that plastics can degrade after long-term exposure to a total vacuum, which is approximately 28" Hg. These studies were not made available to State Water Board staff. However, it is significant to note that existing vacuum monitoring methods apply far less vacuum than is referred to by commenters. Vacuum monitoring systems operate at levels below the UL-approved vacuum rating of piping. We discussed this issue with various piping manufacturers, and none of them expressed any concerns about use of their products with the vacuum levels used for vacuum monitoring.

16. The interstitial space of the piping is the "component" being monitored. (ML-H-2, ML-H-9)

Comment not incorporated. The term "component" is not specifically defined in Chapter 6.7 of the Health and Safety Code or in Chapter 16 of Title 23 of the California Code of Regulations. Therefore, the dictionary definition of the term applies. The plain dictionary meaning of the word component is "an element of a system." Thus, the use of the term "component" in the definition of "Interstitial Liquid Level Measurement" (ILLM) Method refers to the elements (or components) of an underground storage tank, which include the tank and its connected piping. (Health & Saf. Code, § 25281, subd. (y)(1).) Both of these components (the tank and the piping) have primary and secondary levels of containment. The space between the primary and secondary is considered the interstitial space. (Cal. Code Regs, tit. 23, § 2611.) The comment appears to arise from the statement in the definition of ILLM that "the liquid in the interstitial space shall be maintained at a pressure greater than the operating pressure found within the component(s) being monitored." The use of the term "component" here refers to the space within the tank or piping that is the next internal level of containment from the interstitial space. (For piping, this means the primary pipe that contains pressurized product.) The fact that the definition of ILLM uses the terms "interstitial space" and "component" separately underscores the fact that the two have separate meanings.

17. Line leak detection systems will detect breaches in the primary piping and shut off the pump, aiding non-over-pressured ILLM systems in preventing releases to the environment. (ML-H-5)

Comment not incorporated. Line leak detectors are required on pressurized piping per Health and Safety Code, Ch. 6.7, section 25290.1(h). This requirement is in addition to, and independent of, the requirement for continuous vacuum, pressure, or over-pressured ILLM monitoring. Line leak detectors are designed to reduce the amount of product lost during a catastrophic piping failure. They are capable of detecting leaks of 3.0 gallons per hour at 10 psi. (equal to approximately 6 gallons per hour at pump operating pressure) from the primary piping. Because line leak detectors are only sensitive to large leaks from primary piping, they cannot be relied upon to meet the statutory performance standard for detecting breaches in primary and secondary containment before any hazardous substance is released to the environment.

APPENDIX

SUMMARY OF THE ABILITY OF VARIOUS MONITORING SYSTEMS TO MEET THE PERFORMANCE GOAL

The following is an explanation of how various monitoring systems either do or do not meet the performance goal of being able to detect a breach in the primary and secondary before a release to the environment. Each will be discussed with respect to the three scenarios for breaches of the primary and secondary containment:
1. Breach of primary only
2. Breach of secondary only
3. Breach of primary and secondary, either simultaneously or at a staggered time interval

Tank or Piping Vacuum Systems work by maintaining a vacuum condition in the interstice (the space between the primary and the secondary), which is kept dry. Through use of vacuum applied to the interstice, the method relies on the physics of flow through an orifice to act to prevent hazardous substances from being released to the environment.
1. **Breach of primary only**: The vacuum pulls the hazardous substance out of the primary containment through the breach into the interstice, resulting in a decreased vacuum level. The vacuum pump will turn on and attempt to restore the vacuum level, thereby evacuating any hazardous vapors directly into the primary tank or atmosphere (depending on the model of monitoring system). Any liquid in the interstice will be sucked into a liquid sensor. The system detects the liquid, a vacuum loss, or both, and sounds an alarm before the hazardous substance is released to the environment.
2. **Breach of secondary only**: The vacuum pulls the non-hazardous substance outside the secondary containment (air or groundwater) through the breach into the secondary containment, resulting in a decreased vacuum level. The vacuum pump will turn on and attempt to restore the vacuum level. The system detects a vacuum loss and sounds an alarm before the hazardous substance is released to the environment.
3. **Breach of primary and secondary, either simultaneously or at a staggered time interval**: Air, groundwater, and liquid or vapor-phase hazardous substance enters the interstice, resulting in a decreased vacuum level. The vacuum pump will turn on and attempt to restore the vacuum level. Both scenarios described above under #1 and #2 occur. The system detects liquid in the interstice and/or a vacuum loss and sounds an alarm. Because the alarm sounds before all vacuum has been lost from the interstitial space, the vacuum continues to act to prevent any substance from escaping the interstice and the breaches are detected prior to the release of the hazardous substance into the environment.

Meets Performance Standard: Under all three scenarios, vacuum monitoring systems are able to detect breaches in the primary and secondary containment before the hazardous substance is released into the environment.

Tank or Piping Pressure Systems work by maintaining a pressure condition in the interstitial space, which is kept dry (filled with inert gas). Through use of pressure applied to the interstice, the method relies on the physics of flow through an orifice to act to prevent hazardous substances from being released to the environment.
1. **Breach of primary only**: The pressure in the interstitial space pushes against the breach so that the hazardous substance stays inside the primary containment. The pressurized gas moves from the interstice into the primary containment, resulting in a pressure loss in the

interstice.   The system detects a pressure loss and sounds an alarm before the hazardous substance is released to the environment.

2. **Breach of secondary only**: The pressurized gas moves from the interstice into the environment, resulting in a pressure loss in the interstice. The system detects a pressure loss and sounds an alarm before the hazardous substance is released into the environment.
3. **Breach of primary and secondary, either simultaneously or at a staggered time interval**: The pressure in the interstitial space pushes against the primary breach so that the hazardous substance stays inside the primary. The pressurized gas moves from the interstice into the primary containment and the environment, resulting in a pressure loss in the interstice. The system detects a pressure loss and sounds an alarm before the hazardous substance is released to the environment. Because the alarm is activated long before all pressure has been lost from the interstitial space, the pressure continues to act to keep the substance from the environment and the breaches are detected prior to the release of the hazardous substance into the environment.

Meets Performance Standard: Under all three scenarios, pressure-monitoring systems are able to detect breaches in the primary and secondary containment before the hazardous substance is released into the environment.

Tank ILLM Systems ("Brine Tanks") work by completely filling the interstice between the primary containment (tank) and secondary containment with a monitoring liquid. Inside the primary containment (tank), the stored hazardous substance is not pressurized, as it is for pressurized piping. Since the monitoring fluid reservoir is on top of the tank, the monitoring liquid in the interstice is continuously at a higher pressure than that of the hazardous substance stored in the primary containment. Through use of hydrostatic head pressure applied to the interstice, the method relies on the physics of flow through an orifice to act to prevent hazardous substances from being released to the environment.

1. **Breach of primary only:** The pressure in the interstice forces monitoring liquid through the breach and into the primary tank, acting to prevent hazardous substance from moving through the breach and into the interstice. The liquid loss from the interstice results in a drop of liquid level in the reservoir. A liquid sensor detects this drop, and an alarm is activated before the hazardous substance is released into the environment.
2. **Breach of secondary only:** The pressure in the interstice forces monitoring liquid through the breach and into the surrounding environment. The liquid loss from the interstice results in a drop of liquid level in the reservoir. A liquid sensor detects this drop, and an alarm is activated before the hazardous substance is released into the environment.
3. **Breach of primary and secondary, either simultaneously or at a staggered time interval:** The pressure in the interstitial space forces monitoring liquid through the primary breach and into the tank, acting to prevent hazardous substance from moving through the breach and into the interstice. The monitoring liquid also moves through the secondary breach and into the environment. The liquid loss from the interstice results in a drop in liquid level. Note that all scenarios lead only to a drop, not a rise, in the liquid level, therefore there can be no offsetting drops and rises that could mask a release[4]. A liquid sensor detects the drop in liquid level, and an alarm is activated before the hazardous substance is released into the environment. Because the alarm is activated long before all monitoring liquid has been lost

[4] In the unlikely event that groundwater levels directly surrounding the tank are significantly higher than the monitoring reservoir, water may flow into the interstice when a breach occurs in the outer tank wall. This would increase the liquid level in the interstice, although the pressure differential between the interstice and the primary tank ensures that no hazardous substance can escape to the environment. Tank failures of this nature are typically detected through the discovery of excess water in the bottom of the primary tank.

from the interstitial space, the over-pressured monitoring liquid continues to act to keep the hazardous substance out of the environment, and the alarm activates prior to the release of the hazardous substance into the environment.

Meets Performance Standard: Under all three scenarios, tank ILLM systems ("brine tanks") are able to detect breaches in the primary and secondary containment before the hazardous substance is released into the environment.

Non-over-pressured ILLM Systems (as proposed for pressurized piping)

Non-over-pressured ILLM systems have a monitoring liquid in the interstitial space, with a reservoir and high and low level liquid sensors. The interstitial space is at a lower pressure then the primary piping, but the reservoir height (typically 2 or 3 feet) creates a greater pressure in the interstice than the atmospheric pressure found in the surrounding environment. Under certain conditions hazardous substance can move from the primary piping to the interstitial space, and from the interstitial space to the surrounding environment. There is no pressure differential acting to prevent a release to the environment under operating conditions.

1. **Breach of primary only:** When the pump is turned on to dispense product, pressure in the primary piping forces hazardous substance into the secondary. When the pump is turned off, pressure in the primary piping drops and monitoring liquid may flow through the breach and into the primary piping. This transfer of liquid back and forth between primary and secondary piping continues until either the high or low level set point is reached, at which point an alarm sounds. Note that under this scenario, it is possible to generate both drops and rises in liquid level. At any given time, these drops and rises could offset each other. Monitoring liquid may enter the primary piping and hazardous substance may enter the interstice, but no hazardous substance will escape to the environment because the secondary wall is tight.
2. **Breach of secondary only:** Monitoring liquid will move through the breach and out to the environment. The primary containment is intact, so no hazardous substance can move out. The liquid loss from the interstice results in a drop in liquid level. A liquid sensor detects this drop, and an alarm is activated. No hazardous substance will escape to the environment because the primary wall is tight.
3. **Breach of primary and secondary, either simultaneously or at a staggered time interval**: When the pump is turned on to dispense product, pressure in the primary piping forces hazardous substance through the inner wall breach and into the interstice. When the pump is turned off, pressure in the primary piping drops and monitoring liquid (now mixed with hazardous substance) may flow through the inner wall breach and into the primary piping. At the same time, monitoring fluid (now mixed with hazardous substance) will move through the outer wall breach and out to the environment. The rate of flow through the both inner and outer wall breaches will increase when the pump is on and decrease when the pump is off. This transfer of liquid from primary to secondary piping, and secondary piping to the environment will continue until either the high or low level set point is reached, at which point an alarm sounds.

   Unlike over-pressure ILLM discussed above, with non-over-pressured ILLM monitoring of pressured piping, it is possible for leak scenarios to generate both drops and rises in liquid level. At any given time, these drops and rises could offset each other. With both the primary and secondary containment breached, this offset could lead to a release to the environment prior to alarm. Therefore, this method does not satisfy the performance standard.

The amount of hazardous substance released to the environment prior to alarm will vary depending on several factors, including:

- Primary piping pressure
- Frequency and duration of dispensing (pump on/off time)
- Monitoring reservoir size (change in volume required to activate an alarm)
- Monitoring reservoir height
- Size of primary and secondary breaches
- Shape of primary and secondary breaches
- Amount of time between the development of primary and secondary breaches
- Distance of primary and secondary breaches from one another
- Distance of primary and secondary breaches from the monitoring reservoir
- Slope of piping
- Viscosity of the hazardous substance
- Viscosity of the monitoring liquid
- Dimensions of the piping interstice
- Structural integrity of the primary and secondary piping materials.

Does Not Meet Performance Standard: Under the third scenario, non-over-pressured ILLM systems for pressurized piping are NOT able to detect breaches in the primary and secondary containment under all scenarios prior to releases of hazardous substances into the environment.